Coupled Quantitative Precipitation Estimation and Distributed Hydrological Modeling

Case Study for the Russian-Napa Rivers, CA

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NOAA's Hydrometeorology Testbed – West (HMT-W) project is assessing the value of gap-filling radars for improving precipitation estimates in regions of variable terrain. The Russian-Napa river (RNR) basins north of San Francisco, CA comprise the case study for this presentation. Quantitative precipitation estimation (QPE) has involved fusing radar reflectivity and rainfall gage data using the operational NWS Multi-sensor Precipitation Estimator (MPE) and the NSSL developed Multi-radar Multi-sensor Precipitation System (MRMS) software systems to obtain multiple precipitation fields for assessment. A key aspect has been the use of the commercial KPIX C-band TV radar which provides low level scans at high temporal and spatial resolution over the southern half of the Russian River basin to supplement the ~4-km NEXRAD radar products which are blocked by mountains surrounding the basins. The Russian river basin is shown to have significant orographic precipitation influences at higher elevations and a rain shadow effect in the valley.

The Research Distributed Hydrologic Model (RDHM) developed by the NWS Office of Hydrologic Development (OHD) has been loosely coupled to the HMT-W radar QPE fields to aid evaluation of their accuracy. The RDHM allows representation of the spatial variability of precipitation, terrain and soil moisture processes. Base model parameter data for grid connectivity and soils were provided by the OHD as part of their efforts for a nation-wide hydrologic model database. The RDHM was applied using the HRAP ~4-km grid scale and 6-hour time step for a two-year period for calibration and validation using archived QPE data developed by the California-Nevada River Forecast Center (CNRFC). The RDHM simulations showed high correlation with gaged flood peak flows and timing. The model was then applied for the March 2012 flood events using the various MPE/MRMS QPE fields. For the March 2012 flood events we also applied a 1-km grid scale and 1-hour time step and compared RDHM simulations for the two scales.

Results of the precipitation data fusion and hydrological modeling research indicate that the gap-filling radar-gage fields are able to resolve precipitation space and time variability across the RNR basins. Further, the RDHM flood peak simulations reflect responses to the rainfall variability and provide an excellent means to assess QPE accuracy. Monitored soil moisture time variability showed close correspondence with model simulation results; demonstrating potential that soil moisture monitoring can inform the hydrological model for forecasting purposes.

HMT intends to continue prototyping coupling of high resolution QPE with the hydrological model in the RNR to firm up definition of the best QPE method. A goal is to eventually have the coupled system hosted at one or more of the local NWS Weather Forecast Offices. This would attempt to replicate a similar system developed by the Alaska River Forecast Center being tested for the state of Hawaii. This research-to-operations (R2O) effort will support efforts to improve flash flood monitoring and prediction at local scales and leveraging the flash flood guidance provided by the CNRFC.